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Angular information of scientific echosounders for bivalve abundance assessment II (in situ pilot campaign)

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Overview

- Introduction
- Sea campaign
- Acoustic methodology
- Results
- Conclusion
- Future works

Introduction

The present study was performed within the framework of the project **VENUS**. This is funded by European Regional Development Fund, within program **Interreg Spain - Portugal.**

Stay tuned about Venus activities -> www.project-venus.com

The main topic of this project is related with the comprehensive study of the natural population of bivalve molluscs in the Gulf of Cadiz for the sustainable management and conservation of their associated habitats.

Project is divided in several tasks.

Underwater acoustics are involved in “Planning and development of sampling campaigns aimed at spatial characterization of natural population of bivalve molluscs and associated habitat”. IGIC offers a techical advice in acoustical operations.

Active underwater acoustic techniques are applied with a double goal:

- Bottom classification
- Striped venus (*Chamelea gallina*) abundance comparative estimation.

Introduction

Steps followed during the life of the project contain different kind of campaigns and tests:

July 2018

- Tank assay
  - Numerical simulations.
  - Image textural analysis of angle-echograms
  - Textural features depending on the amount of scatterers
    - H1 – angular second-moment
    - H8 – entropy sum
    - H9 – entropy
    - H11 – entropy difference
    - Lacunarity

April 2019

- **Pilot campaign**
  - 3 days / 9 measurement stations (E1, E2, …, E9)
  - Methodology test (feasibility, utility…)
  - Adaptation and improvement of the methodology

May-June 2019

- Full-coverage campaign
  - 21 days / 112 measurement stations
  - Methodology application and validation

Sea campaign

PILOT CAMPAIGN

It was planned to mesure 9 stations, classified by distance from bottom to transducer and striped venus comparative density.

	High density	Medium density	Low density
4 m	E1	E4	E7
6 m	E2	E5	E8
8 m	E3	E6	E9

Test fishings were carried out by a hydraulic dredge in different areas in order to find suitable ones to be measurement stations, attending to bottom distance and density.

Next steps were perform in each station:

1. Delimitation of a 150 m legth transect, parallel to shoreline, 50 m out to sea from previous fishing.
2. Acoustic survey. No less than three times.
3. Sediment samplings using Van Veen dredge, focussed on granulometry and faunistic studies.
4. Striped venus fishing using the hydraulic dredge. (Sizes harvested > 2cm)

} groundthruthing

Sea campaign

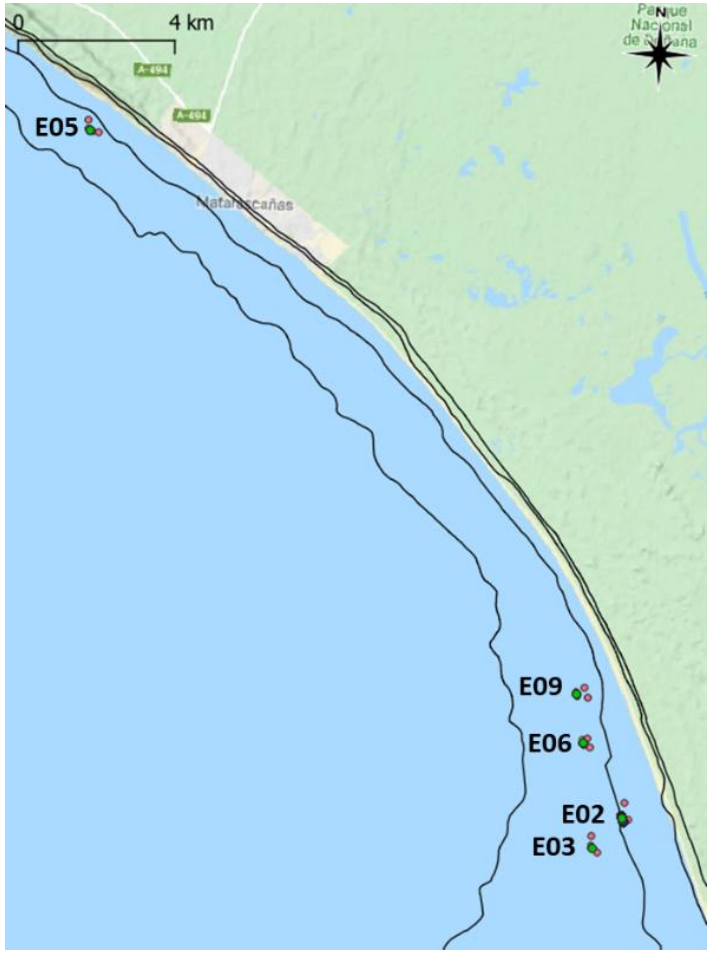
PILOT CAMPAIGN

Stations measured

	High density	Medium density	Low density
4 m	E1	E4	E7
6 m	E2	E5	E8
8 m	E3	E6	E9

Striped venus density and biomass, amount of gravel and seabed type for each station

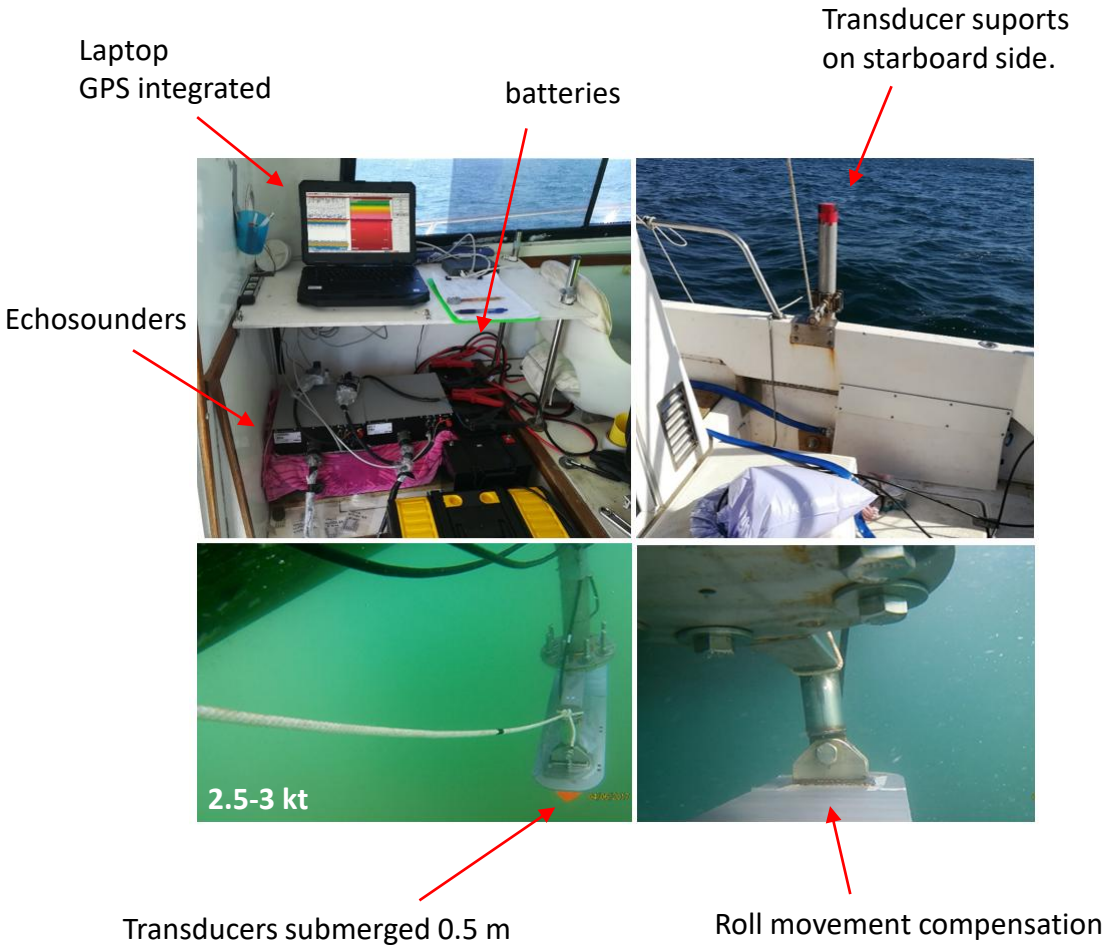
Estation	density (ind/m^2)	biomass (g/m^2)	gravel (g/m^2)	Sediment (FOLK classification)
E9	2.42	11.5	0.38	Very Fine Sand
E5	8.56	41.82	99.83	-
E6	34.63	153.07	8.18	Very Fine Sand
E3	37.76	152.61	3.05	Very Fine Sand
E2	87.03	439.06	209.99	Very Fine Sand



East of Gulf of Cadiz map, where location of measured stations is shown.

Acoustic data acquisition

PILOT CAMPAIGN, experimental set up



Characteristics and configuration of acoustical devices:

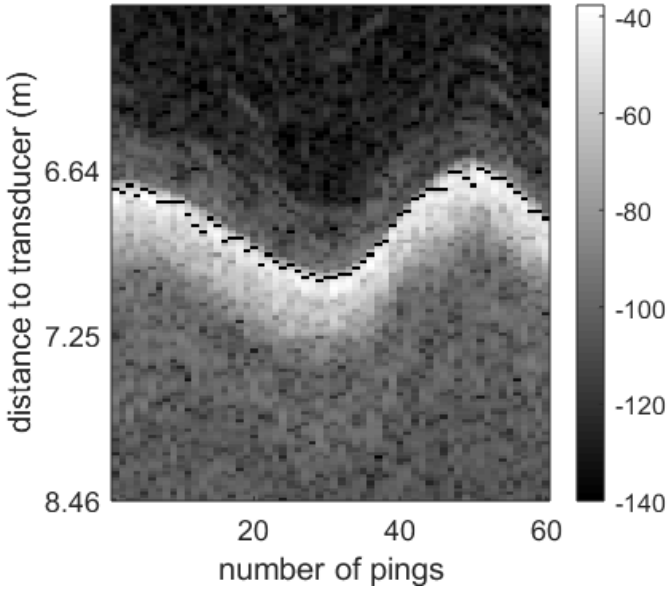
Transceiver	Simrad EK60		Simrad EK80
	Single beam	**Split beam**	**Split beam**
Transducer	Combi 38/200 D	ES200-7C	ES120-7C
Pulse	CW	CW	FM fast
Frequency	38 kHz	200 kHz	90 - 170 kHz 130 kHz
Beam apertura	13 º alongship	6.6 º	6.15 º
(-3 dB)	21 º athwartship		
Power	200 W	150 W	250 W
Pulse duration	0.064 ms	0.064 ms	0.512 ms
Sample interval	0.016 ms	0.016 ms	-
Ping interval	100 ms	100 ms	100 ms

Acoustic data analysis

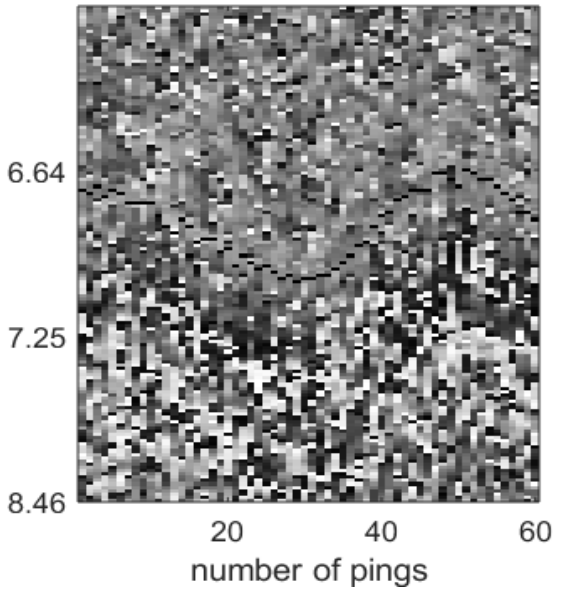
PILOT CAMPAIGN, underwater acoustics analysis performance

Preprocessing, implemented in Matlab®

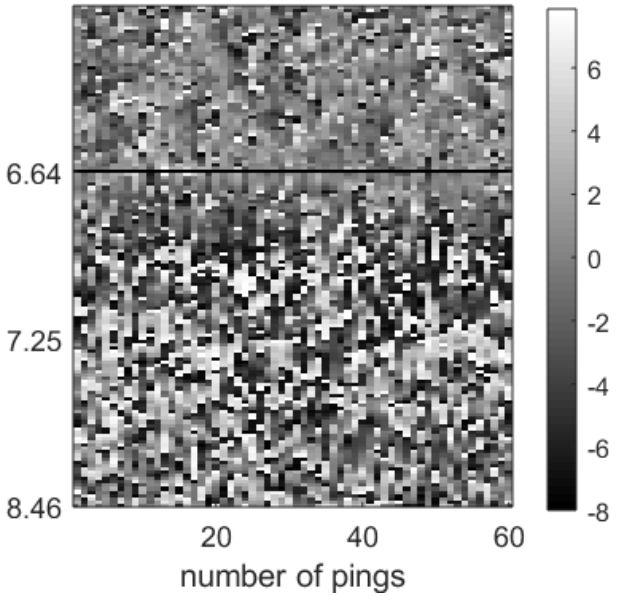
1. **Transects selection:** sections with changes in boat heading and speed, and out of line delimeted are removed.
2. **Ping selection:** Transects are divided in 60 correlative pings.
3. **Bottom line correction:** bottom is detected from intensity echogram and corrected in alongship angle echograms.



RAW EK60 energy echogram



Alongship angle echogram (°)



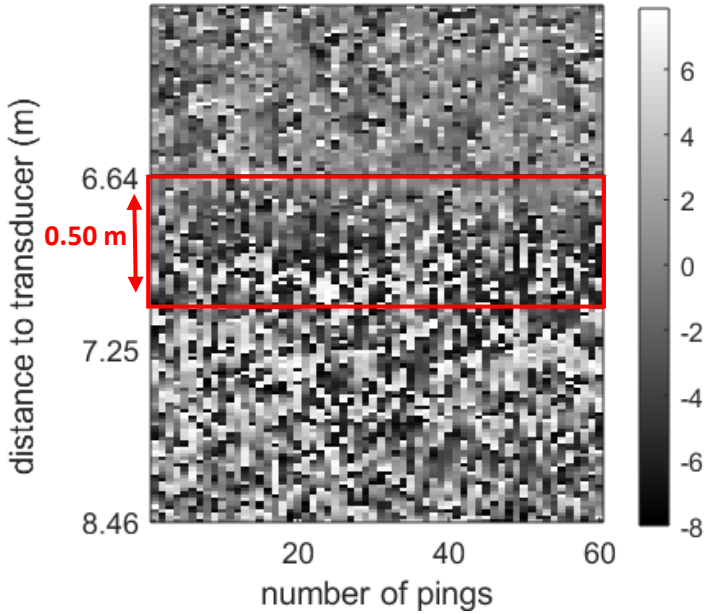
Alongship angle echogram (°) with bottom line corrected

Acoustic data analysis

PILOT CAMPAIGN, underwater acoustics analysis performance

Processing, implemented in Matlab ®

- **Input:** First 0.5 m from bottom of Alongship angle echogram (60 pings) corrected.
- **Algorithm:** Image textural analysis (Haralick et al., 1973)
  For each pixel, co-ocurence matrix and textural features are calculated (Haralick ones + lacunarity).
  Parameters defined: neighborhood size (3·5), direction of spatial relationship (horizontal), number of quantization levels of the angles (5).
- **Output:** textural features echograms (size: 0.5 m, 60 pings)



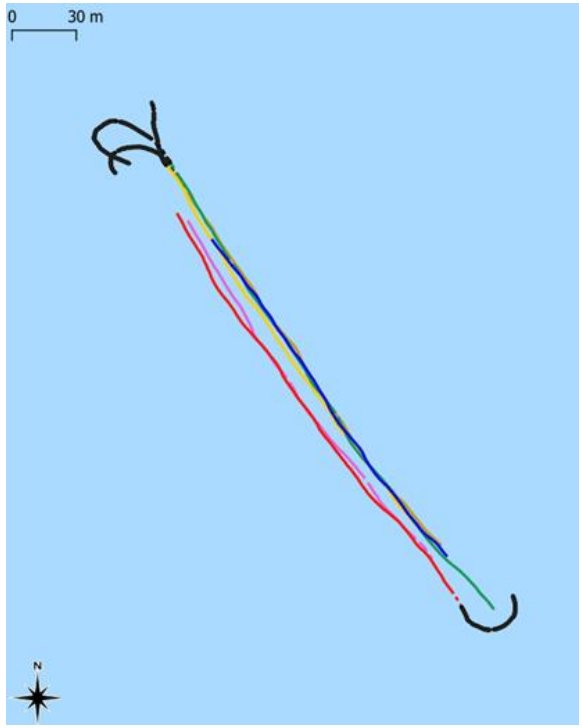
Alongship angle echogram (°) with bottom line corrected and range selected

Statistical analysis, implemented in Statgraphics®

1. Textural features means are calculated from every echogram interval.
2. Principal Component Analysis is applied in order to reduce the number of variables: Sinthetic uncorrelated variables are obtained (principal components).
3. Relationship between density of striped venus and principal components is studied. Finally, a linear regression,, by least squares method, between density and one component is applied.

Results

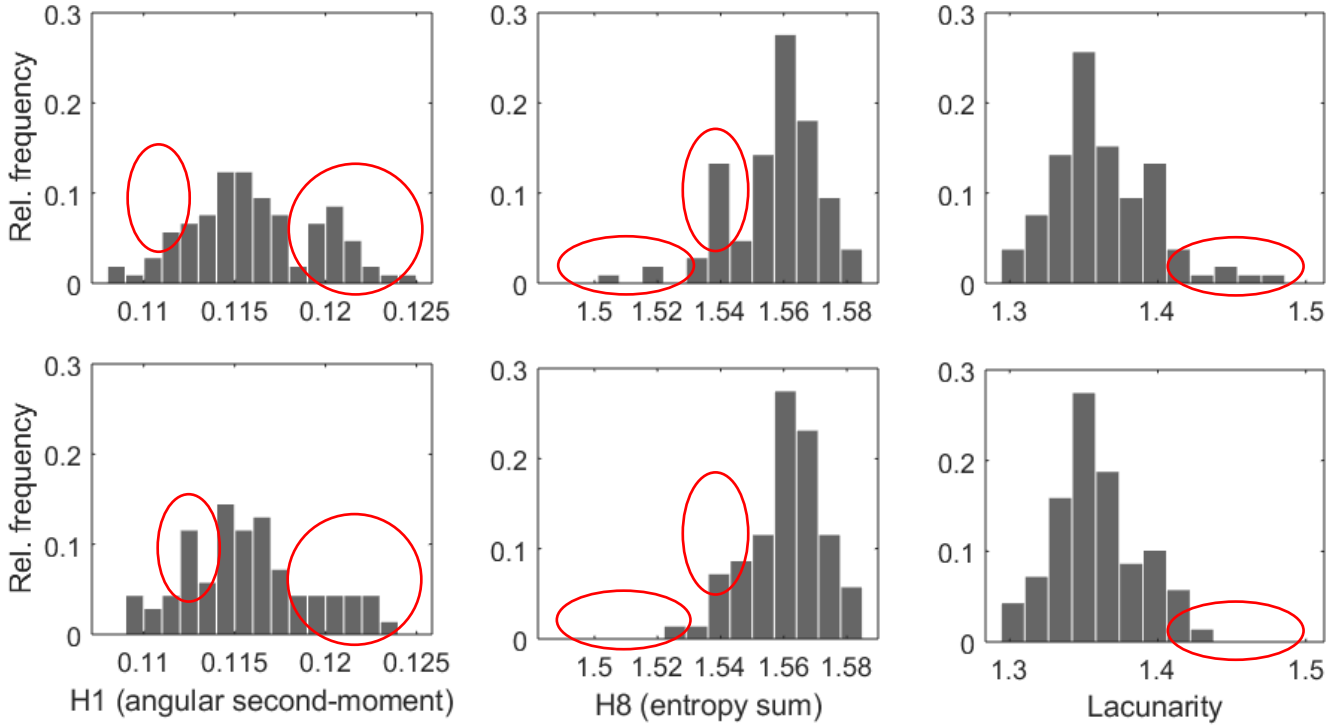
Significant changes in boat course and speed influence textural features distributions.



Detail of E3 transects.

With significant changes of boat heading and speed →

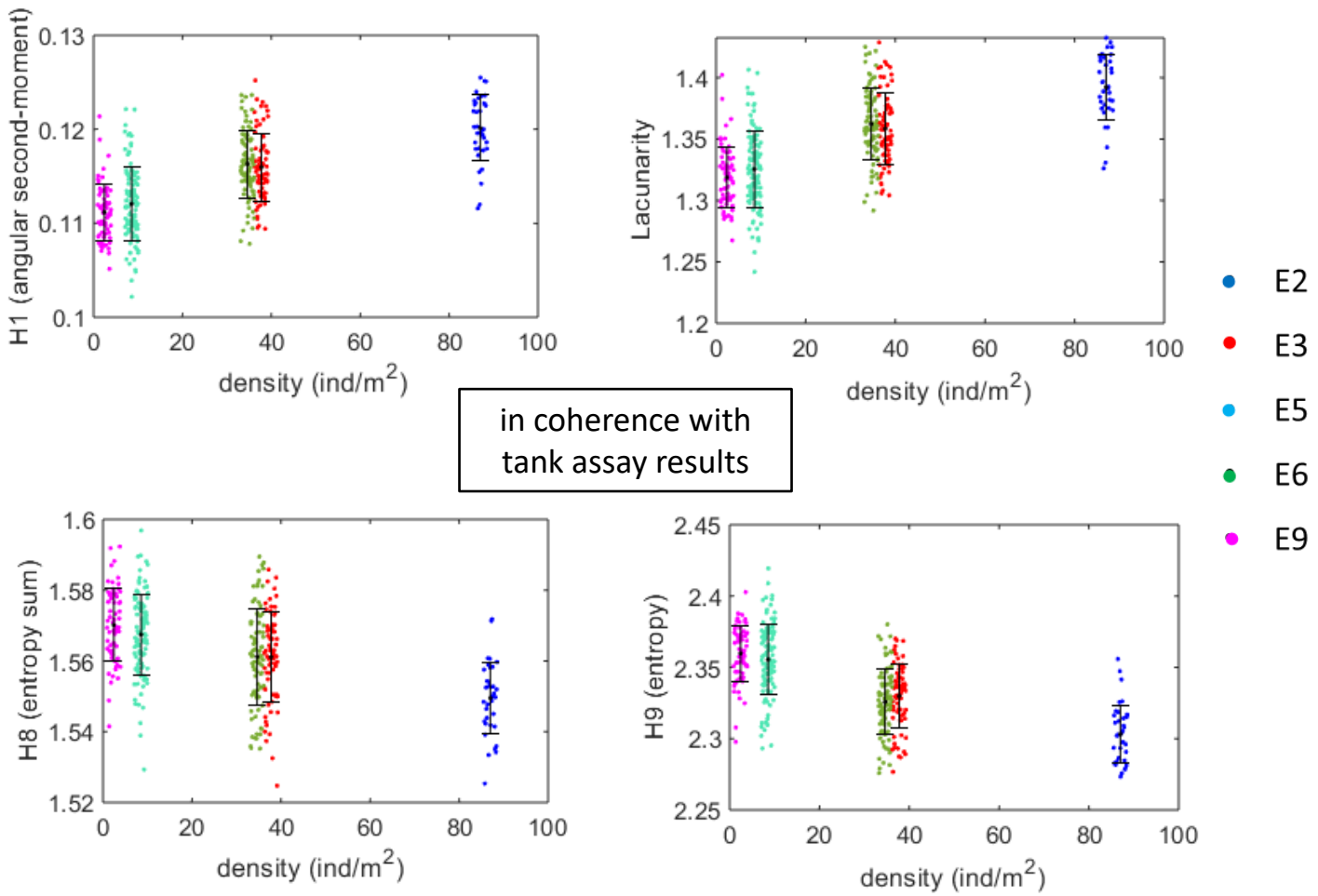
Constant ship heading and speed →



Examples of differences in distributions for 3 textural features before and after remove sections with extensive changes in boat course and speed .

Results

Some features show upward or declining trends with density increase of stripped venus: H1, H4, H8, H9, H10, H11, H12 and lacunarity. Examples:

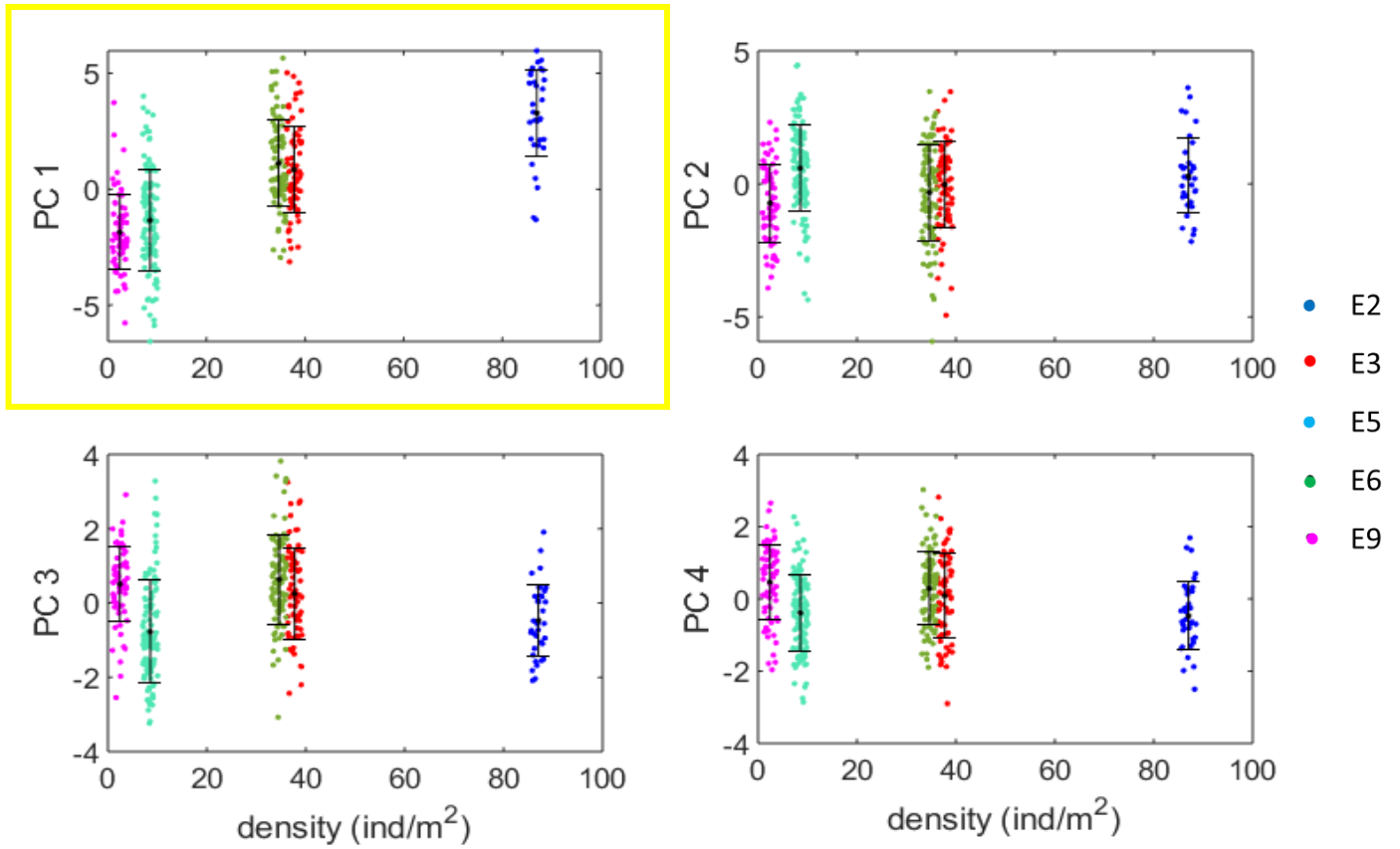


Variations in neighborhood and quantization parameters do not affect too much the behaviour of the features related with density.

Results

Principal Component Analysis reduces total number of features to 4 components.

Components	Eigenvalue	Percentage of Variance	Cumulative Variance
PC 1	6,3245	48,650	48,650
PC 2	2,83209	21,785	70,435
PC 3	1,81564	13,966	84,402
PC 4	1,22908	9,454	93,856
PC 5	0,46207	3,554	97,411
PC 6	0,20539	1,580	98,991
PC7	0,0679355	0,523	99,513
PC 8	0,0430267	0,331	99,844
PC 9	0,0100137	0,077	99,921
PC 10	0,00595857	0,046	99,967
PC 11	0,00349995	0,027	99,994
PC 12	0,000798121	0,006	100,000
PC 13	3,96526E-16	0,000	100,000



Only component PC 1 shows a trend related with density variation. For its calculation the variables with more weight are in bolt:

PC 1 = **0,390·H1** + 0,205·H2 + 0,154·H3 + **0,288·H4** + 0,226*H5 - 0,199*H6 + 0,163*H7 **- 0,283·H8 - 0,389·H9** + **0,366·H10** - 0,193*H11 - 0,161*H12 + **0,391·Lac**

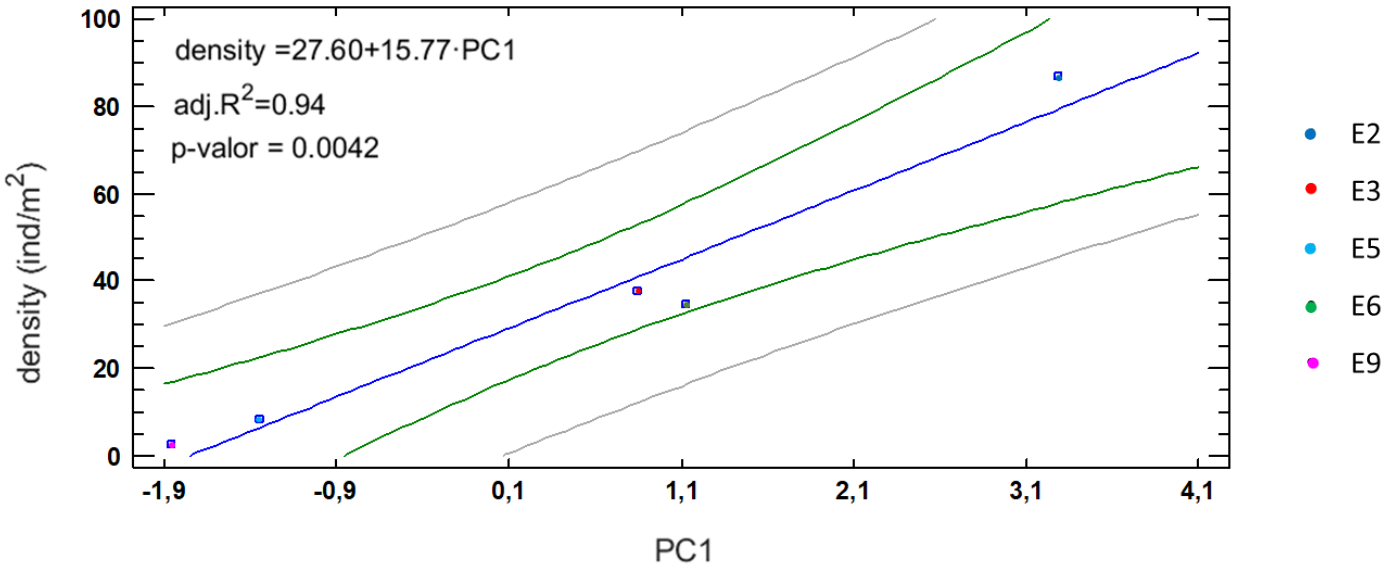
Results

Linear regression between means of PC 1 for each station and density of striped venus has been performed.

The model obtained explains the 94 % of variabily in density.

The external interval is the prediction for new observations of density at 95% confidence.

Internal is confidence interval for the media of many observations at 95% confidence.



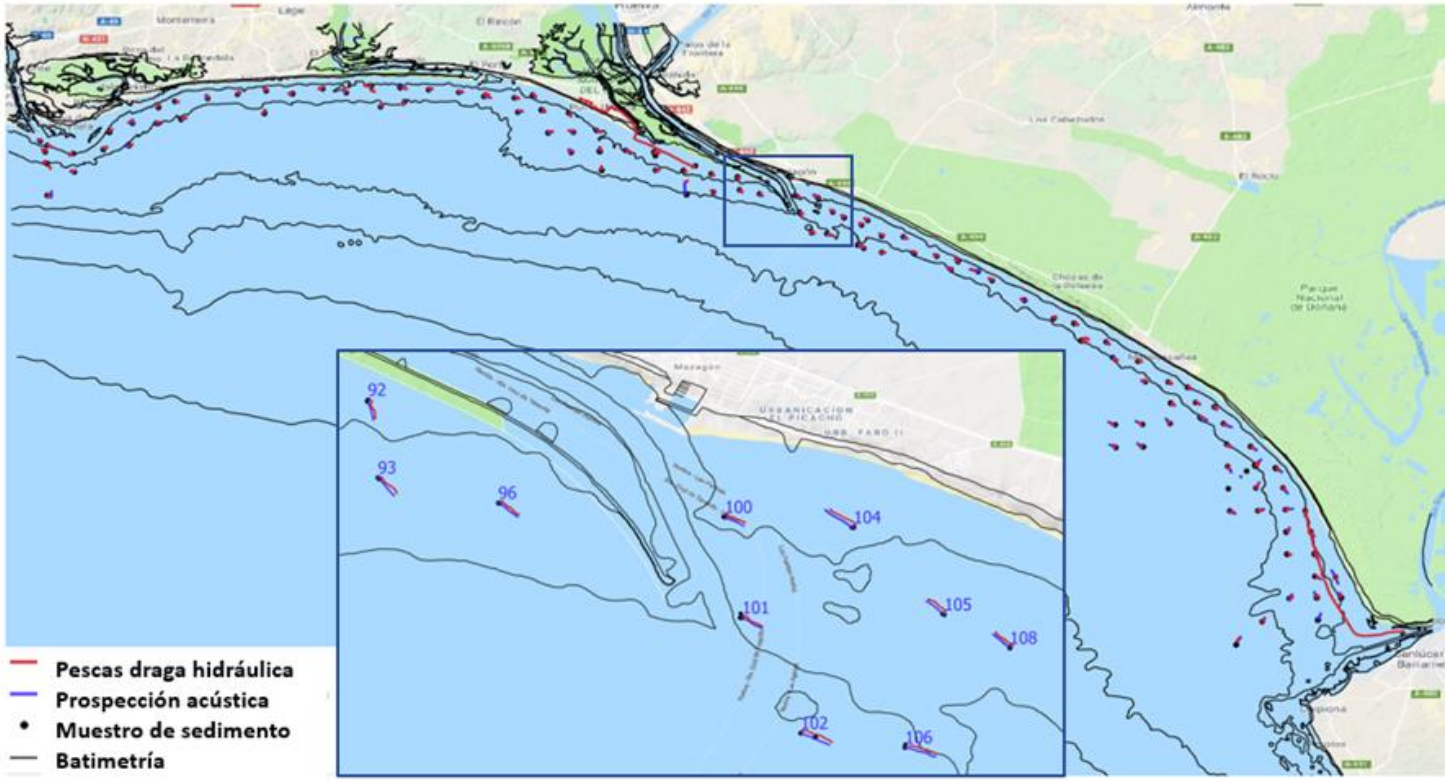
Multiple regression have been carried out considering PC 1 and PC 2 but the model does not improve.

Conclusion

- Relationship between striped venus density and acoustic signal is observed.
- Procedure designed in tank assay has been validated as suitable for striped venus density estimation in situ conditions, using parallel transects to shoreline and seabed with similar characteristics.
- This method could be implemented to monitor striped venus density variation in the same fishing area along time.

Work in progress

- A full coverage campaign of Gulf of Cádiz have been carried out and designed technique is being applied.



- Seabed echo energy analysis is being taken into account in order to consider more variables in the model.

Thanks